SIMPSON DVM'S

~~360 460 464~~

464 / 464D

Simpson
INSTRUMENTS THAT STAY ACCURATE

SERVICE

SERVICE BULLETIN
#76-2
OCTOBER 1976
OEM

OEM SERVICE,
TROUBLE SHOOTING,
AND PARTS INFORMATION

MODELS 464A and 464D

DIGITAL MULTIMETERS

DIVISION OF AMERICAN GAGE & MACHINE CO. • A KATY INDUSTRIES, INC. Subsidiary

KATY INDUSTRIES
ELECTRICAL COMPONENT GROUP

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PART ONE

GENERAL INFORMATION AND SPECIFICATION

Simpson Electric Company has always provided a quality product to its customers and will continue all efforts in this direction. In compliance with Safety Regulations we post certain Caution and Warning Notes in appropriate places in this bulletin. These notes in no way reflect a change in our quality standards and are posted only as a reminder to Service Personnel to adhere to safe service practices and return the repaired instrument to the customer as the quality product the original design provided.

> This Instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, the following notes must be read carefully and completely before making any measurements or adjustments. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 Of ANSI C39.5-1974.

Note: The proper measuring instrument for the measurement of leakage current consists essentially of a network of 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

Refer to GENERAL SAFETY PRECAUTIONS on next page.

GENERAL SAFETY PRECAUTIONS

The unit is to be serviced only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD definition.

Do not work alone when making measurements where a shock hazard can exist. Notify another person that you are, or intend to make such measurements.

Remember, voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured and remove all power from the unit before making connections or disconnections. The Instrument itself is well protected against electrical overload. However, the above precautions are wise even in the laboratory, and especially in field usage of the Instrument where many strange or unknown safety hazards might prevail.

Locate all voltage sources and accessibility paths prior to making any measurements or connections.

For your own safety, before each use, inspect the test leads, prods, connectors and power cable for cracks, breaks, or crazes in the insulation. If any defects exist, destroy and replace the defective item(s) immediately.

Do not make measurements in a circuit where corona is present. Corona can be identified by a pale blue color emanating from sharp metal points in the circuit or a buzzing sound, or the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates presence of high voltage, and probably a malfunction of some kind.

Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or the Instrument.

For maximum safety, do not touch test leads, circuit, or Instrument while power is applied to the circuit being measured.

Use extreme caution when making measurements in an rf circuit where dangerous composite voltages could be present, such as in a modulated rf amplifier.

Do not use test leads which differ from those originally furnished with the Instrument.

Before the Instrument is used for AC operation, make sure that the "third wire" on the AC power cord is connected to an earth or power line ground.

Do not float any measuring terminal more than 1000 volts (DC plus AC peak) with respect to the power line or earth ground.

PART TWO

GENERAL INFORMATION

SCOPE

This bulletin contains maintenance information for the Simpson Model 464 Digital Multimeter (also referred to herein as a DMM). Only factory-authorized Service Centers should perform the adjustments and servicing contained in this bulletin. The Operator's Manual (part no. 5-118430) contains all operating information. The service technician should understand thoroughly the entire contents of the Operator's Manual before attempting any procedure in this manual.

GENERAL DESCRIPTION

The Simpson Model 464 DMM is a compact, 3½ digit instrument with a 0.43" planar LED display. Analog-to-digital conversion is accomplished by two Large-Scale-Integration (LSI) circuits using a charge-balancing technique. Auto-zeroing is provided to minimize the effects of offset, drift, and temperature. Pushbutton switches select the desired function and range.

Two versions of the Model 464 are available. The Model 464A is designed for line operation at either 120 V or 240 V, 50-400 Hz. The Model 464D provides either line or rechargeable battery (not supplied) operation using four D-size nickel-cadmium cells. All data apply to both versions unless otherwise noted.

Complete technical specifications are given in table 2-1; items supplied with the DMM are listed in table 2-2.

Table 2-1. Technical Data

1. DC VOLTAGE

Range	Maximum Indication	Input Resistance	Overload Protected To
200 mV	±199.9 mV	10 MΩ	±1100 V
2 V	±1.999 V	10 MΩ	±1100 V
20 V	±19.99 V	10 MΩ	±1100 V
200 V	±199.9 V	10 MΩ	±1100 V
1000 V	±1000 V (Max. Input)	10 MΩ	±1100 V

Accuracy: ±(0.2% of reading + 1 digit) on 200 mV and 2 V ranges (from +15° to + 35°C) ±(0.5% of reading + 1 digit) on 20 V, 200 V, and 1000 V ranges.

Table 2-1. Technical Data (continued)

Input Bias Current:	40 pA at reference conditions
Sensitivity:	100uV at 200 mV range.
Full Range Step Response: (to rated accuracy)	1 second, maximum
Normal Mode Rejection:	55 dB minimum at 60 Hz
Common Mode Rejection:	90 dB minimum at 60 Hz
Overrange Capability:	Linear to 1000 counts beyond maximum indication (except on 1000V range, where any indication greater than 1100 is an overload).
Temperature Coefficient:	±(0.01% of reading +0.05 digit) /°C

2. AC Voltage (Average-Sensing, RMS Calibrated Sine Wave 40 Hz to 10 kHz):

Range	Maximum Indication	Input Impedance	Overload Protected To
200 mV	199.9 mV	10 MΩ and 75 pF	650 V rms
2 V	1.999 V	10 MΩ and 75 pF	650 V rms
20 V	19.99 V	10 MΩ and 75 pF	650 V rms
200 V	199.9 V	10 MΩ and 75 pF	650 V rms
600 V *	600 V (Max. Input)	10 MΩ and 75 pF	650 V rms

* Frequency Range: 40 Hz to 1000 Hz.

Accuracy: (from +15°C to + 35°C)	±(0.5% of reading + 2 digits), 40 Hz to 1000 Hz. ±(1.0% of reading + 2 digits), 1000 Hz to 10 kHz.
Sensitivity:	100 uV on 200 mV range
Full Range Step Response: (to rated accuracy)	5 seconds, maximum
Temperature Coefficient: (from 0°C to +55°C)	±(0.05% of reading + 0.05 digit) /°C

Table 2-1. Technical Data (continued)

3. RESISTANCE:

Range	Maximum Indication	Full Scale Voltage	Test Current	Overload Protected To
200 Ω	199.9 Ω	200 mV	1 mA	135 V rms
2 kΩ	1.999 kΩ	2 V	1 mA	135 V rms
20 kΩ	19.99 kΩ	2 V	100 mA	250 V rms
200 kΩ	199.9 kΩ	200 mV	1 uA	250 V rms
2000 kΩ	1999 kΩ	2 V	1 uA	250 V rms
20 MΩ	19.99 MΩ	2 V	100 nA	250 V rms

Accuracy: ±(0.5% of reading + 1 digit) except on the 20 MΩ range, which is ± (1.0% of reading + 1 digit)

Sensitivity: 0.1Ω on 200Ω range

Full Range Step Response: (to rated accuracy) 2 seconds, except on 20 MΩ range, which is 7 seconds

Temperature Coefficient: (from 0°C to +55°C) ±(0.05% of reading +0.05 digit) /°C

Overrange Capability: Linear to 1000 counts beyond maximum indication

4. DC CURRENT:

Range	Maximum Indication	Full Range Voltage Drop	Overload Protected To
200 uA	±199.9 uA	200 mV	±2.5 A*
2 mA	±1.999 mA	200 mV	±2.5 A*
20 mA	±19.99 mA	200 mV	±2.5 A*
200 mA	±199.9 mA	200 mV	±2.5 A*
2000 mA	±1999 mA	200 mV	±2.5 A*
10 A	±10.00 A (Max. Input)	100 mV	±10 A

* Fuse Protected

Accuracy: (from +15°C to +35°C) ±(0.5% of reading + 1 digit), except on 2000 mA and 10 A ranges, which are ±(1.0% of reading + 1 digit)

Sensitivity: 100 nA on 200 uA range

Full Range Step Response: (to rated accuracy) 1 second

Table 2-1. Technical Data (continued)

Temperature Coefficient: (from 0°C to +55°C)	±(0.05% of reading +0.05 digit) /°C
Overrange Capability:	Linear to 500 counts beyond maximum indication (except on 10 A range, where any indication greater than 1000 is an overload

5. AC CURRENT (40 Hz to 10 kHz):

Range	Maximum Indication	Full Range Voltage Drop	Overload Protected To
200 uA	199.9 uA	200 mV	2.5 A*
2 mA	1.999 mA	200 mV	2.5 A*
20 mA	19.99 mA	200 mV	2.5 A*
200 mA	1999.9 mA	200 mV	2.5 A*
2000 mA	1999 mA	200 mV	2.5 A*
10 A	10.00 A (Max. Input)	100 mV	10 A

* Fuse Protected

Accuracy: (from +15°C to +35°C)	±(1.5% of reading + 2 digits), except On 2000 mA and 10 A ranges, which are ±(2.0% of reading + 2 digits)
Sensitivity:	100 nA on 200 uA range
Full Range Step Response: (to rated accuracy)	5 seconds, maximum
Temperature Coefficient:	±(0.1% of reading + 0.1 digit) /°C
Overrange Capability:	Linear to 500 counts beyond maximum indication (except on 10 A range, where any indication greater than 1000 is an overload.

6. RATED-CIRCUIT-TO-GROUND VOLTAGE: (Maximum Common Mode Voltage) — 1000 volts (DC plus peak AC) maximum from any measuring terminal to power line (earth) ground terminal.

7. RESOLUTION: 1 part in 2000

8. DISPLAY:

Numerical Display:	3-1/2 digit, 7-segment light-emitting-diode (LED) type, with flashing digits for counts over 1999.
Conversion Rate:	3 readings per second, nominal

Table 2-1. Technical Data (continued)

DC Polarity Selection:	Automatic with "+" or "-" indication
9. POWER REQUIREMENT:	
AC Operating (464A) or Battery Charging (464D):	120 VAC or 240 VAC ±10% (check rear panel designation), 50-400 Hz, 5 VA nominal.
Battery Operation (464D):	Four nickel-cadmium "D" size rechargeable cells, Eveready type CH4 or equivalent (each cell is rated at 1.25 V, 4-ampere-hours). 8 VA nominal
Battery Operation Time: (continuous with fully charged battery)	8 hours, nominal
Battery Recharge Time:	16 hours, nominal
10. TEMPERATURE RANGE:	
Operating:	0°C to +55°C
Storage:	-40°C to +60°C
11. RELATIVE HUMIDITY:	0 to 90% (non-condensing)
12. REFERENCE CONDITIONS:	
Temperature:	+23°C ±1°C
Relative Humidity:	30 to 60%
Atmospheric Pressure:	575 to 800 mmHg
13. DIMENSIONS:	
Height:	2.70 in (68.6 mm)
Width:	8.40 in (213.4 mm)
Depth:	9.00 in. (228.6 mm)
14. WEIGHT:	Approximately 3 lbs. (1.36 kg)

Table 2-2. Items Furnished With Instrument

Quantity	Description	Part No.
1	Test Lead Set: One black and one red insulated lead having probe tipswwith provisions for screw-on alligator clips (one red and one black supplied).	10-830115
1	Power Cord	5-118916
1	Operator's Manual	5-118430

PART THREE

INSTALLATION AND OPERATION

GENERAL

This part includes information about battery installation (Model 464D only) and checking. Changing the required line voltage is also detailed.

All operating information is contained in the Operator's Manual part no. 5-118430.

UNPACKING

When unpacking the DMM, check for obvious damage. Be sure that all accessories are removed from the shipping carton before discarding it.

BATTERY INSTALLATION (MODEL 464D ONLY)

After verifying that the DMM is OFF and that all connections to the power line and other equipment are disconnected, rotate the handle (by pulling out the knobs on each side of the case) to the rear of the unit.

Lay the DMM upside-down on a soft, flat surface and remove the four screws in the rubber feet.

Lift off the bottom cover and remove the handle.

Remove the two tubes from the battery holder and install the cells into the tubes. Replace the tubes into the battery holder, being careful to observe the polarities indicated on the battery holder label. Batteries will not operate when reversed because of a lock-out feature on the battery holder.

CAUTION

Incorrect battery insertion
can damage the DMM.

To reassemble, replace the handle in its original position (make sure that the elbow in the handle is toward the bottom cover). Reinstall the bottom cover and the four rubber feet.

CHARGING THE BATTERY

Because nickel-cadium cells are generally supplied in a discharged condition, newly installed cells should always be charged before use.

To charge the D-cells quickly (about 16 hrs), turn the DMM off and connect the line cord to the AC line. The battery will also charge, but at a much slower rate, if the DMM is operated from the AC line while the battery is installed.

CHECKING THE BATTERY

Depress the DCV and 20 (10A) pushbuttons and connect a jumper from the BATTERY TEST JACK to the V-Ω jack.

The DMM display should be between +4.7 and +6.0 V. If it is below +4.7 V, either the battery is installed incorrectly or it needs charging.

Note: If the battery is missing or installed incorrectly, the display will indicate the open-circuit charging voltage (5.0).

CHANGING THE LINE VOLTAGE REQUIREMENT

To modify the DMM for 240 V operation remove the bottom cover (see BATTERY INSTALLATION, p. 3-1).

Remove the four hexagonal spacers and the two screws securing the power transformer. Lift the printed circuit board and front panel from the top cover.

Between the rear edge of the printed circuit board and the power transformer are two terminals soldered into two holes marked "120 V". To modify the DMM for 240 V operation, unsolder and remove these terminals. Reinsert one terminal in the single hole labelled "240 V" (between the 120 V holes) and solder. Be sure that the solder covers both pads shorted together by the terminal and that there is no solder bridging where the two terminals were removed.

Reinstall the printed circuit board and front panel. Remove the 1/4 A, 250 V, 3 AG fuse and replace it with a 1/8 A, 250 V, 3 AG fuse.

Reassemble the handle and bottom cover.

PART FOUR

MAINTENANCE

GENERAL

This part contains all maintenance information for the Models 464A and 464D DMMs. Troubleshooting and disassembly information is provided. The calibration procedure is given, followed by an insulation breakdown test to assure customer safety. A series of Performance Checks evaluate overall DMM operation.

Parts location information and the complete parts list are contained in Part Five.

TROUBLESHOOTING

Additional troubleshooting aids contained herein are the schematic diagram (fig. 6-1), typical waveforms (fig. 4-2), and troubleshooting charts (tables 4-8 and 4-9).

A careful visual inspection before troubleshooting will often reveal any defect. Check for broken leads or solder connections, over-heated components, loosened foil, etc.

CALIBRATION

The test equipment listed in table 4-1 is required to calibrate the Model 464.

Table 4-1. Required Test Equipment

Description	Required Accuracy
1. DC Voltage Source, 0 to 1000 V	0.02% of setting
2. DC Current Source 0 to 10 A	0.05% of setting
3. AC Voltage Source, 0 to 600 V rms, 40 Hz to 1000 Hz 1000 Hz to 10 kHz	0.05% of setting 0.1% of setting

Table 1-1. Technical Data (continued)

4.	AC Current Source, 0 to 10 A, 40 Hz to 10 kHz	0.15% of setting
5.	Resistance Standard, 0 to 20 Megohm	0.05% of setting
6.	DMM	Simpson Model 460-2
7.	Dielectric Withstanding Tester, 1500 V and 3000 V rms, 60 Hz	
8.	120 V AC socket with "hot" & "common" terminals (not earth ground) connected together.	

Visual Inspection & Disassembly Procedure

1. Lay the DMM upside-down on a smooth, flat surface.
2. Remove the four rubber feet from the bottom of the case.
3. Carefully lift the bottom of the case from the case top and printed circuit board.
4. Note the position of the handle and remove it.
5. Inspect all components for broken leads and obvious damage. Check that all leads are securely soldered. Make sure the line fuse is installed and not open. Look for solder splashes or bridges and remove any that are found.
6. If it is necessary to inspect the bottom of the p.c. board, unscrew the four hexagonal spacers. Remove the two screws from the transformer mounting bracket and carefully separate the p.c. board and front panel from the case.
7. After inspecting the bottom of the p. c. board, reinstall it in the case top. Insert the two screws and the four spacers. Tighten these six items.

Calibration Procedure

Unless otherwise noted, all steps apply to both models.

1. Connect the DMM to the ac line, turn it on, and allow a 15 minute warm-up. (Model 464D only) Remove the battery (if installed).

2. (Model 464D only) Set the Simpson Model 460-2 to the 2000 dc mA range. Connect the positive lead to the positive battery terminal and the negative lead to the negative battery terminal. Adjust R81 (see fig. 4-1) for a display of 450 mA. Disconnect the Model 460-2.

3. The entire calibration procedure is presented in table 4-2. All adjustments are shown in fig. 4-1. Perform each step in the indicated sequence.

Dielectric Withstanding Test

This test should be performed on each instrument after repair and/or calibration. The interior of the instrument should be carefully inspected, and all pieces of wire and excess solder must be removed. The instrument must be cased during this test.

- Safety Precautions for Working with High Voltage

  1. Dielectric withstanding tests must be performed only in the presence of another person who understands the nature of the test and the emergency procedures that may be required.

  2. Be thoroughly familiar with the dielectric tester being used. Know how to operate it safely in accordance with the manufacturer's directions.

  3. Never touch any of the high voltage leads (or parts connected to them) when the dielectric tester is turned on.

  4. All connections and adjustments should be made using only one hand. For greatest safety, place the unused hand in a pocket to avoid accidental contact with any other object.

  5. Always begin a test with the dielectric tester output at zero volts. Slowly and steadily increase the output voltage to the required level.

  6. Upon completion of the test, or a failure, lower the output voltage slowly and steadily.

  7. Do not turn off the dielectric tester when the output voltage is greater than zero except in an emergency.

- Test Procedure

  1. Verify that the dielectric withstanding tester output is set to zero and that the tester is turned off.

  2. Connect a shorting bar between the COMMON and V-Ω input jacks. Connect one lead of the tester to this shorting bar and the second lead to the 3rd wire (earth) ground of the power cord.

TABLE 4-2. CALIBRATION PROCEDURE

Step	Model 464 Function	Controls Range	Calibration Source Output	Adjustment	Required Model 464 Display	Notes
1	DC V	200 mV	Short Model 464 input leads	C23	+00.0	Zero Adjustment. Note that "+" sign must be continuously illuminated.
2	DC V	200 mV	170.0 mV DC	R41	170.0 ±1 count	200 mV DC range calibration.
3	DC V	2	1.700 V DC	R40	1.700 ±1 count	2 V DC range calibration.
4	OHMS (kΩ)	2	1,000Ω	R27	1.000 ±1 count	2 kΩ range calibration.
5	OHMS (kΩ)	20 MΩ	10.00 MΩ	R29	10.00 ±1 count	20 Megohm range calibration.
6A	ACV	200 mV	170.0 mV AC 400 Hz	R22		Note the display indication on both ranges. Adjust R22 to split the error around a display of 1700 counts. EXAMPLE: 170 mV reads 1706. 1.7 V reads 1710. Adjust R22 to provide a display of 169.8 mV on the 200 mV range and 1.702 V on the 2 V range.
6B	ACV	2	1.700 V AC 400 Hz			
7	ACV	20	10.00 V AC 10 kHz	C2	10.00 ±1 count	Frequency response adjustment.
8	DC mA	20/10 A	1.000 A DC	R4	1.00 ±1 count	To adjust R4, heat the soldered tap connection and move the tap toward the 10 A jack to increase the display or toward COMMON to decrease the display.
9	DC mA	2000	1000 mA DC	R5	1000 ±5 counts	To adjust R5, heat the soldered connection connecting R5 to the "2000" switch. Slide more of R5 thru the connection to decrease the display. To increase the display, decrease the amount of R5 extending past the soldered connection.
NOTE: After calibrating current shunts, allow them to cool completely and recheck calibration.						

3. Turn on the tester, and slowly increase its output to 3000 V rms. Maintain this level for 60 seconds. Watch for evidence of leakage (exceeding 0.5 mA) or breakdown.

4. At the end of 60 seconds, slowly decrease the tester output to zero and turn off the tester.

5. Disconnect the tester and remove the shorting bar.

6. Connect the Model 464 line cord to the special 120 V ac socket (item 8, table 4-1).

7. Connect one dielectric withstanding tester lead to the shorted socket terminals and the other lead to the third-wire ground terminal.

8. Turn on the tester and slowly increase the output to 1500 V rms. Maintain this voltage for 60 seconds and watch for evidence of leakage (exceeding 0.5 mA) or breakdown.

9. At the end of 60 seconds, slowly decrease the tester output to zero and turn off the tester.

10. Disconnect the tester and the special socket.

PERFORMANCE CHECKS

(Model 464A) Connect the DMM to the 120 V ac power source. Use a 3 wire, grounded receptacle.

(Model 464D) If the (optional) rechargeable battery is to be used for these checks, check the condition of the battery (see p. 2-2). If line power is to be used, connect the DMM to a 3 wire, grounded receptacle.

DC Voltage Accuracy Check

1. Perform each step in table 4-3. Check that the DMM display indicates within the listed tolerance for both positive and negative input polarities (where indicated), and that the decimal point is in the correct location.

Table 4-3. DC Voltage Accuracy Check

Step	Model 464 Range (V)	DC Voltage Std. Output (V)	Display Tolerance (± no of counts)	
			RUN 1	RUN 2
1	200 mV	0*	1	1
2	"	±50.0 mV	2	2
3	"	±90.0 mV	3	2
4	"	±170.0 mV	4	3
5	"	±250.0 mV	6**	4**
6	2	0*	1	1
7	"	+1.700	4	3
8	20	0*	1	1
9	"	+17.00	9	3
10	200	0*	1	1
11	"	+170.0	9	3
12	1000	0*	1	1
13	"	+900.0	6	2

* - Short input leads of DMM together.
** - Display should blink with overrange "1" extinguished.

Resistance Accuracy Check

1. Connect the Model 464 input leads to a resistance standard and perform each step in table 4-4. Check that the display is within the indicated tolerance and that the decimal point is positioned correctly.

Table 4-4. Resistance Accuracy Check

Step	M464 Range (kΩ)	Resistance Std. Value (kΩ)	Display Tolerance (± no of counts)
1	200Ω	0*	1
2	"	100Ω	6
3	2	0*	1
4	"	1.000	6
5	20	0*	1
6	"	10.00	6
7	200	0*	1
8	"	100.0	6
9	2000	0*	1
10	"	1000	6
11	20 MΩ	0*	1
12	"	10.00 MΩ	11

* Short DMM input leads together

DC Current Accuracy Check

1. Connect the Model 464 input leads (connected to the app opriate input jacks) to a DC current standard and perform each ste in table 4-5. Check that the display is within the indicate tolerance and that the decimal point is positioned corr ctly.

Table 4-5. DC Current Accuracy Check

Step	Model 464 Range (mA)	DC Current Std. Output (mA)	Display Tolerance (± no. of counts)
1	200 uA	0*	1
2	"	170.0 uA	9
3	2	0*	1
4	"	1.700	9
5	20	0*	1
6	"	17.00	9
7	200	0*	1
8	"	170.0	9
9	2000	0*	1
10	"	1,000	11
11	10 A	0*	1
12	"	1,000	2

* Short DMM input leads together

AC Voltage Accuracy Check

1. Short the input leads of the Model 464 and check that the display indicates 000 ±1 count on all ranges.

2. Connect the input leads to the AC voltage source and perform each step in table 4-6. Check that the display is within the indicated limits and that the decimal point is properly located.

Table 4-6. AC Voltage Accuracy Check

Step	Model 464 Range (V)	AC Voltage Standard Output (V)	Frequency (Hz)	Display Tolerance (± no. of counts)
1	200 mV	170.0 mV	100	9
2	"	"	10,000	17
3	2	1.700 V	100	9
4	"	"	10,000	17
5	20	17.00	100	9
6	"	"	10,000	17
7	200	170.0	100	9
8	"	"	10,000	17
9	600	600.0	100	4

AC Current Accuracy Check

1. Connect the Model 464 input leads to the AC current standard and perform each step in table 4-7. Check that the display is within the indicated limits and that the decimal point is properly positioned.

Table 4-7. AC Current Accuracy Check

Step	Model 464 Range (mA)	AC Current Standard Output (mA)	Frequency (Hz)	Display Tolerance (± no. of counts)
1	200 uA	0*	400	1
2	"	170.0 uA	"	25
3	20	0*	"	1
4	"	17.00	"	25
5	2,000	0*	"	1
6	"	1,000	"	21

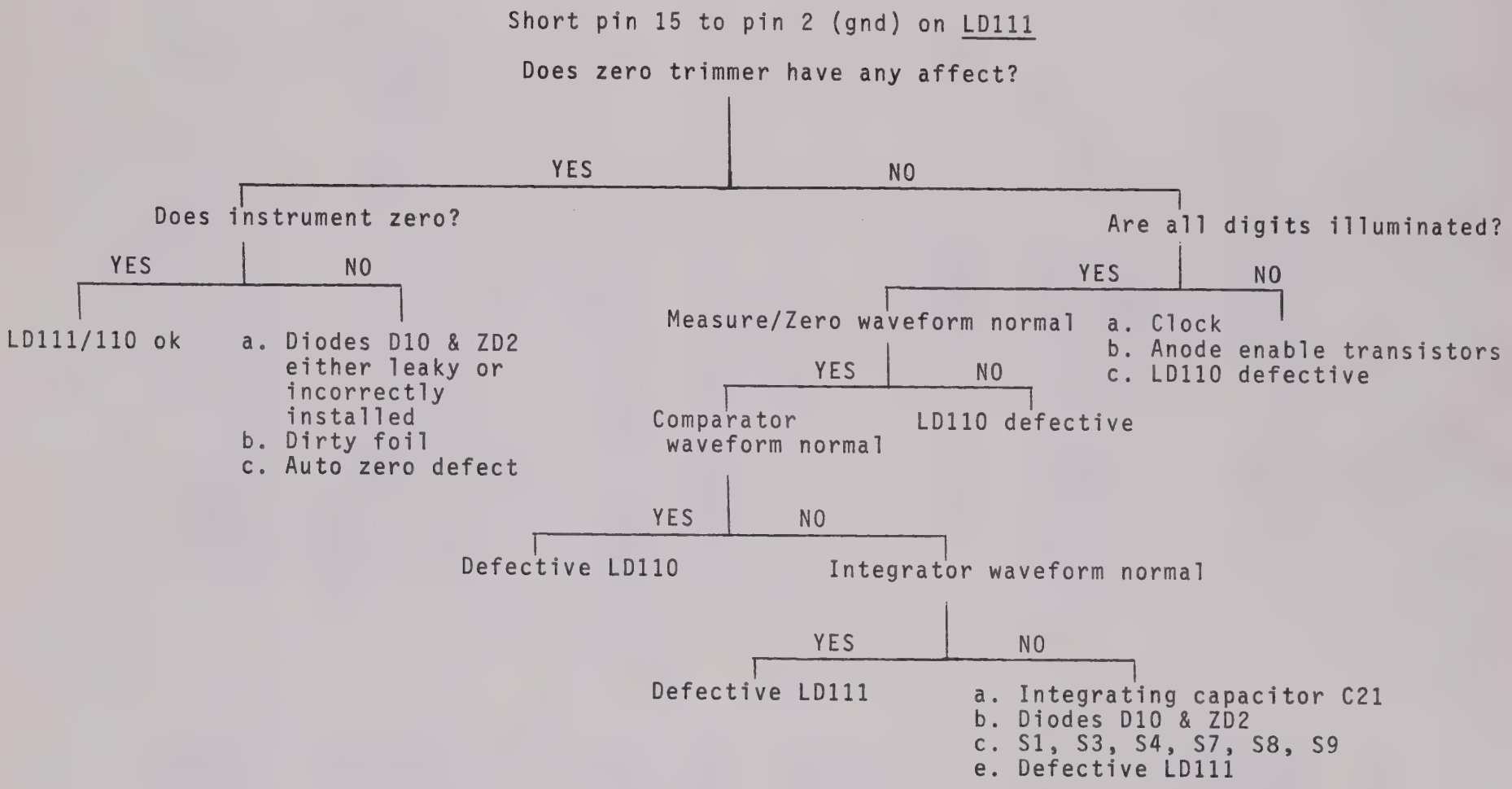
* Short DMM input leads together

- This completes the Performance Checks -

Table 4-8. Troubleshooting Chart

Symptom	Possible Cause	Remedy
1. Dead	a. F1 defective (M464A)	Replace
	b. Defective switch S12 B1	Replace
	c. Defective power supply	Check & repair
2. Display illuminates, but instrument does not respond to any input signal.	a. Defective ±12 V supply	Check & Repair
	b. Clock (IC4) defective	Replace
	c. Q1 & Q2 shorted	Replace
	d. Open input circuitry	Check & repair
	e. IC7 defective	Replace
	f. D10 & ZD2 incorrectly installed	Install correctly
	g. LD110 or LD111 defective	Replace defective IC
3. DMM will not zero	a. Dirt or grease in area of LD111	Clean area thoroughly
	b. Excessive power supply ripple	Check & repair
	c. LD110 or LD111 defective	Replace defective IC
4. Indication out of tolerance	a. Recalibration required	Recalibrate
	b. Defective range resistor	Replace
5. Symmetry (±input) out of tolerance	Zero adjustment required	Adjust zero so that the "+" sign is always illuminated
6. No decimal point or wrong location	Defective switch contact (S5R2, S6A1, S3A1, S4A1, S1A1)	Replace
7. One digit unusually dim or bright	a. Defective anode enable transistor switch (Q6-Q9) or driver transistor (Q10-Q13)	Replace
	b. Defective LD110	Replace
8. Battery will not charge (M464D only)	a. Defective F1	Replace
	b. Defective ni-cad cell	Replace
	c. T1, D17 or D18 defective	Replace
	d. Defective battery contact	Repair or replace
9. DMM does not operate on some function(s)	a. Defective input circuitry	Repair

Table 4-9. Troubleshooting Chart, LD111 & LD110 IC Set



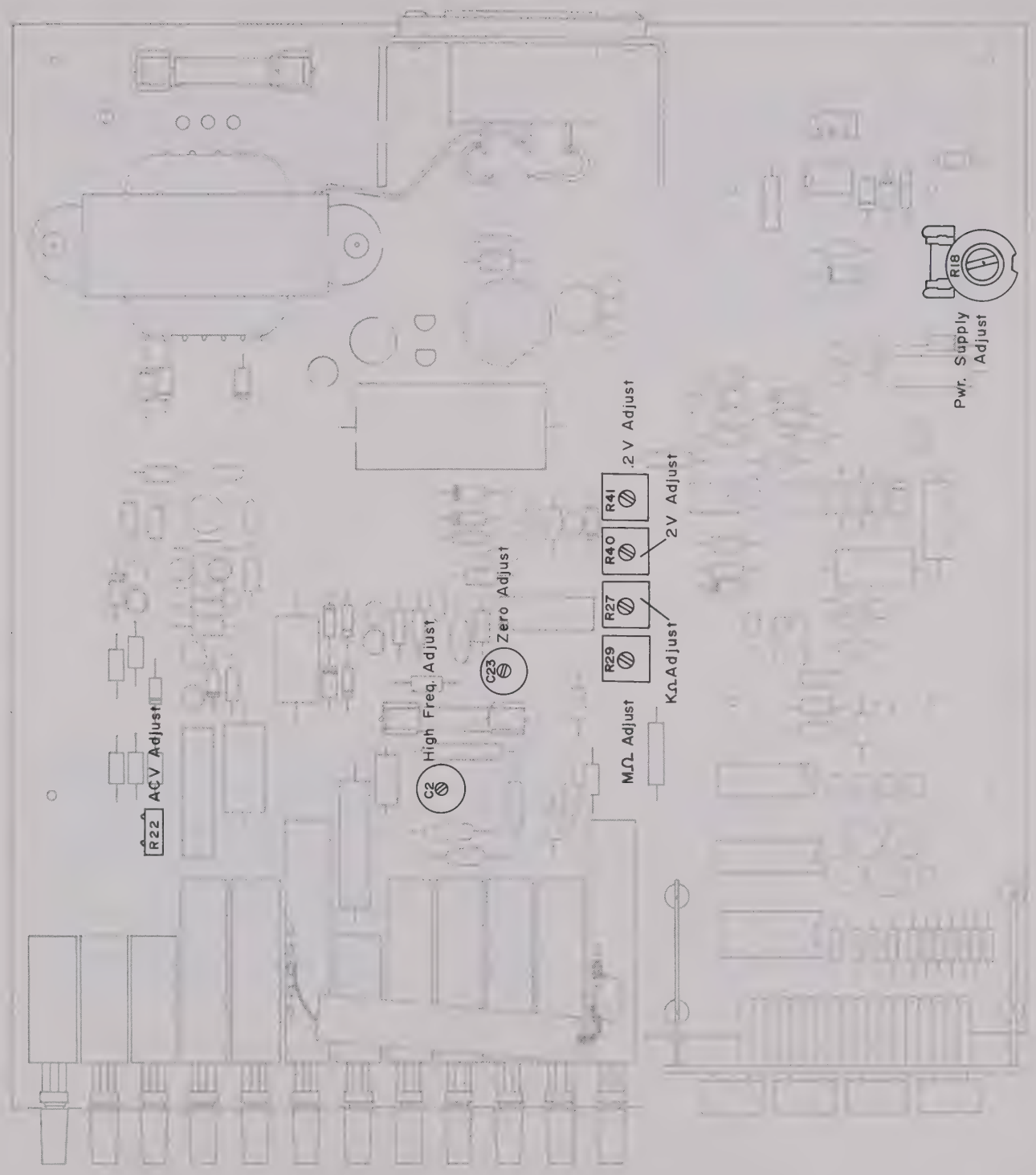
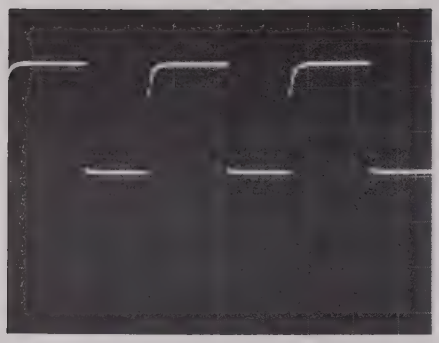
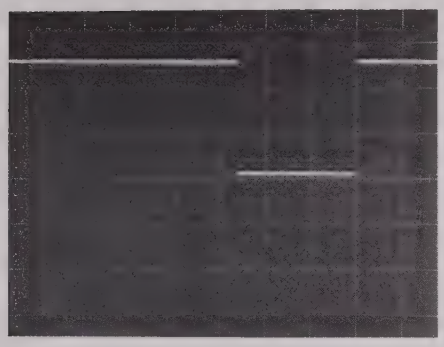


Fig. 4-1. Calibration Adjustment Locations, Models 464A and 464D



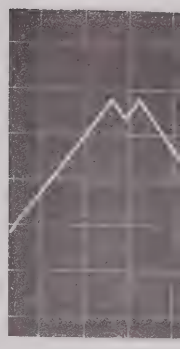
Clock

a) IC4-PIN 3
b) 2V/cm
c) 20us/cm



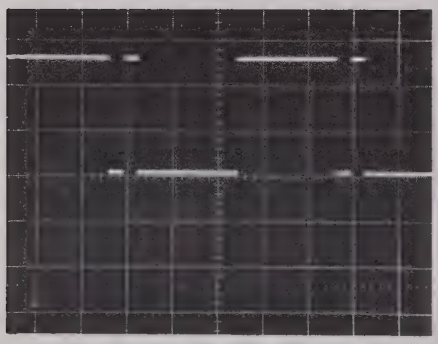
Measure/Zero Signal

a) IC6-PIN 10
b) 2V/cm
c) 50ms/cm



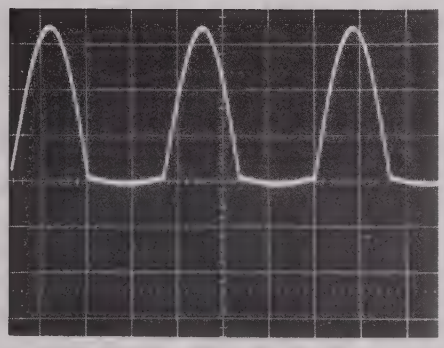
Integrator Ou

a) IC5-PI
b) .2V/cm
c) .5ms/c
d) Ext. T
Zero S



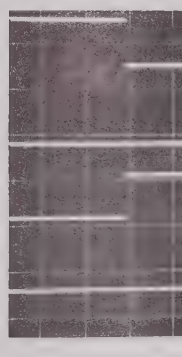
UP/DOWN Signal (Shorted Input)

a) IC6-PIN 9
b) 2V/cm
c) .2ms/cm
d) Ext. Trigger: Measure/
Zero Signal, Pos. Slope



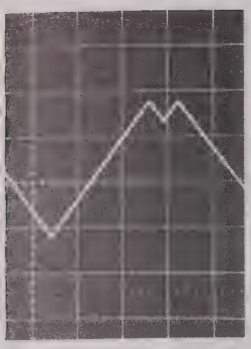
Operational Rectifier Output
(1999 Count Input-60Hz)

a) D2-Cathode Side
b) 2V/cm
c) 5ms/cm



Anode Er

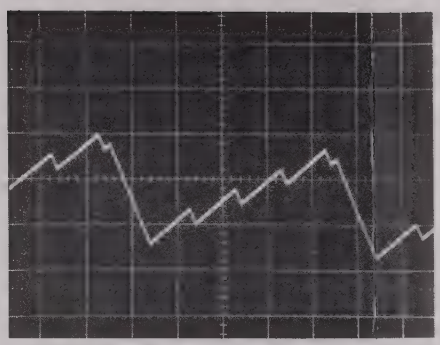
a) IC6-P
b) 5V/cm
c) .2ms/



:put (Input Shorted)

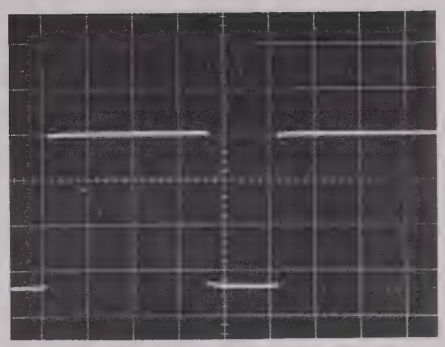
l 11
AC coupled

'igger: Measure/
gnal, Pos. Slope



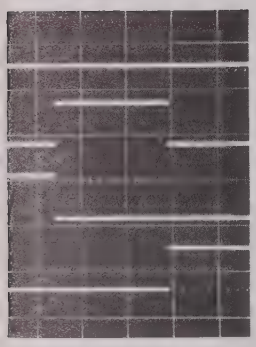
Integrator Output (1999 Count Input)

a) IC5-PIN 11
b) .2V/cm AC coupled
c) .5ms/cm
d) Ext. Trigger: Measure/
Zero Signal, Pos. Slope



Comparator (Shorted Input)

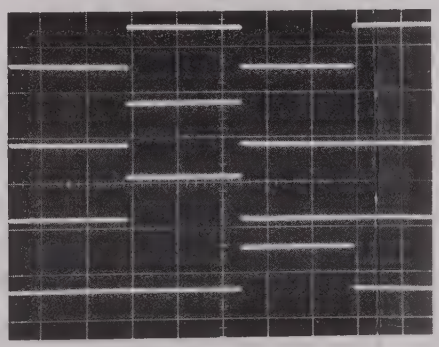
a) IC5-PIN 5
b) 5V/cm
c) .2us/cm
d) Ext Trigger: Measure/
Zero Signal, Pos. Slope



able Signals

INS-1,2,3,&4

cm



BCD Output Signals

a) IC6-PINS - 16, 15, 14, & 13
b) 5V/cm
c) .2ms/cm
d) Ext. Trigger: IC6-PIN 1
Positive Slope

Notes:

1) All waveforms photographed from the Crt. of a Tektronix Model 7403 Oscilloscope with 7A18 vertical amplifiers and a 7B53AN time base. A direct probe was used.

2) Unless otherwise noted:
   a) DC coupling used in vertical amplifiers.
   b) Internal triggering on a positive slope was used.
   c) Oscilloscope ground lead connected to common ground on PC board.

Fig 4-2. Typical Waveforms

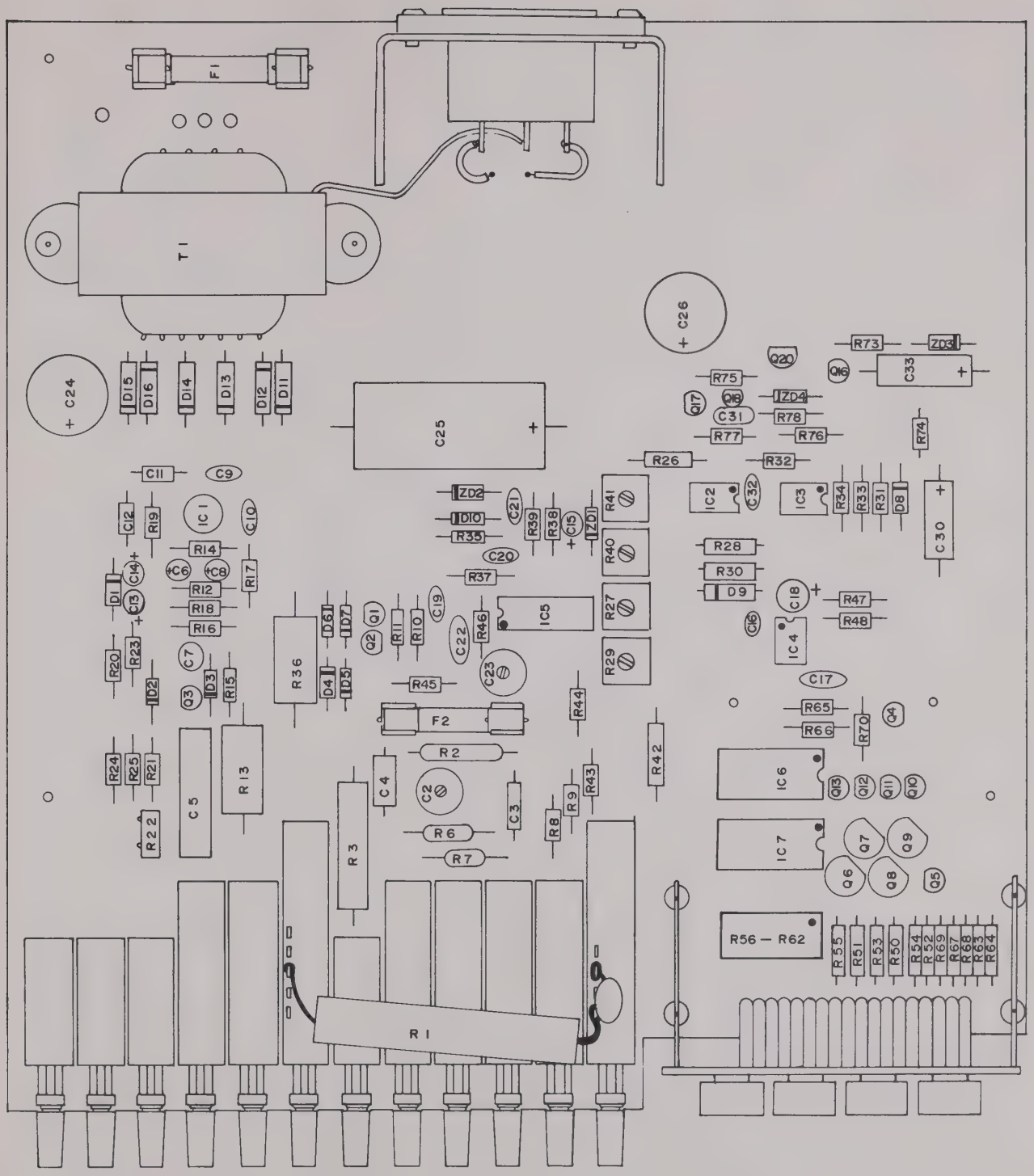


Fig. 5-1. Component Location Information, Model 464A

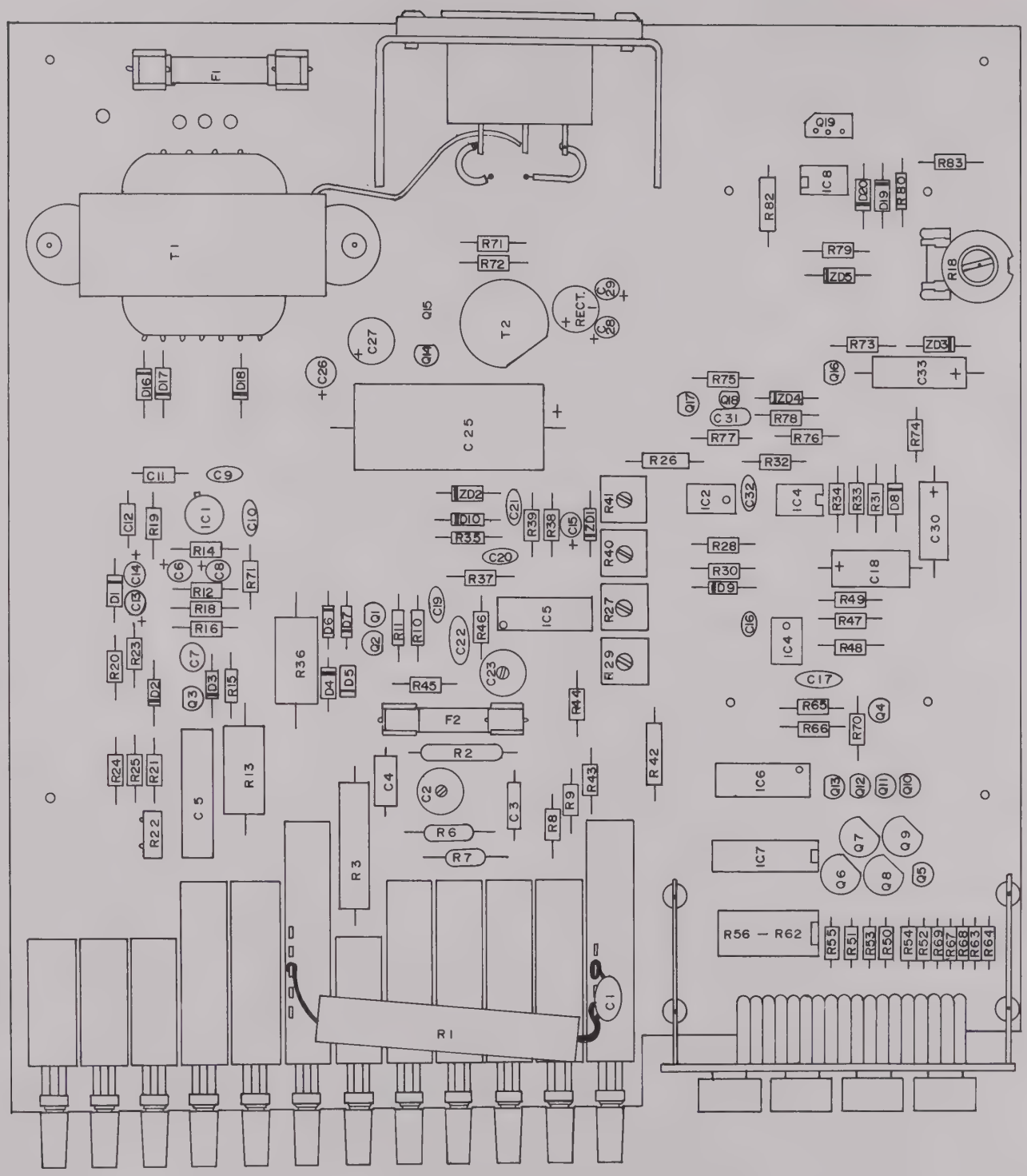


Fig. 5-2. Component Location Information, Model 464D

PART FIVE

PARTS LISTS

GENERAL

This part contains separate parts lists for the Models 464A and 464D digital multimeters. Parts location drawings follow the parts lists.

SIMPSON MODEL 464A DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
	TESTER SECTION	
10-863218	PANEL, ASSEMBLY	
05-118371	PANEL, PURCHASED	
05-118395	PANEL OVERLAY, TOP	
05-118396	PANEL OVERLAY, CENTER	
05-118920	PANEL OVERLAY, BOTTOM	
05-117424	CONN, BANANA JACK, RED	
05-117423	CONNECTOR, BANANA JACK, BLACK	
10-650156	SHUNT, CURRENT, 10 AMP.	
10-863217	CASE ASSEMBLY TOP	
10-863212	BOARD, P.C., ASSY, MAIN	
05-117723	I.C., LD110	IC6
05-117724	I.C., LD111	IC5
05-117150	I.C., NE555V	IC4
05-115927	I.C., DM7447N	IC7
05-115916	I.C., LM301AH	IC1
05-115928	I.C., SN72741P	IC3
05-116598	I.C., LM308N	IC2
05-115931	TRANS, 2N4123	Q1,2,10,11,12,13,18
05-115938	TRANS, 2N5306	Q4,5,17,20
05-112747	TRANSISTOR, 2N5458	Q3
05-117720	TRANSISTOR, 2N5815	Q16
05-114106	TRANSISTOR, 2N3638	Q6,7,8,9
05-117379	DIODE, IN914, SELECTED	D1,2
05-118868	DIODE, DE-113	D3
05-112004	DIODE, IN914	D8,9,10
05-113826	DIODE, IN5059	D4,5,6,7
05-114005	DIODE, 10D1	D11,12,13,14,15,16
05-112634	DIODE, IN753A	ZD4
05-118917	DIODE, IN5239B	ZD2
05-112726	DIODE, IN4743A	ZD3
05-118918	DIODE, IN936	ZD1

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STOCK PARTS

SIMPSON MODEL 464A DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
05-117138	CAP., 3.3PF, 1KV	C1
05-115992	CAP., 47PF, 160V	C11
05-113217	CAP., 100PF, 1KV	C31
05-112690	CAP., 330PF, 500V	C32
05-118405	CAP., 390PF, 250V	C3
05-118406	CAP., 470PF, 250V	C4
05-117201	CAP., .0022UF, 100V	C16
05-113215	CAP., .01UF, 50V	C9,10,17
05-117278	CAP., .01UF, 100V	C7
05-116188	CAP., .022UF, 100V	C20
05-117732	CAP., .033UF, 100V	C19,21
05-118449	CAP., .22UF, 630V	C5
05-113612	CAP., .1UF, 100V	C22
05-118407	CAP., .33UF, 100V	C12
05-115530	CAP., .47UF, 16V	C13
05-116969	CAP., 10UF, 50V	C30
05-115534	CAP., 15UF, 16V	C6,8,14,15,18
05-118408	CAP., 470UF, 25V	C24,26
05-118083	CAP., 4700UF, 10V	C25
05-118409	RESISTOR, 0.897 OHMS	R6
05-118410	RESISTOR, 9.0 OHMS	R7
05-116272	RESISTOR, 90.0 OHMS	R8
05-118411	RESISTOR, 448 OHMS	R24
05-116273	RESISTOR, 900 OHMS	R9
05-117695	RESISTOR, 4.0K OHMS	R30
05-118412	RESISTOR, 4.08K OHMS	R25
05-118413	RESISTOR, 10.0K OHMS	R20,21
05-118414	RESISTOR, 10.0K OHMS	R3
05-114962	RESISTOR, 10.0K OHMS	R33,34
05-116621	RESISTOR, 20.0K OHMS	R45
05-118415	RESISTOR, 36K OHMS	R31,32
05-118416	RESISTOR, 37.5K OHMS	R28
05-116921	RESISTOR, 75K OHMS	R42
05-118417	RESISTOR, 90.0K OHMS	R2
05-115506	RESISTOR, 100K OHMS	R43
05-117519	RESISTOR, 110K OHMS	R44
05-116772	RESISTOR, 402 OHMS	R35
05-118418	RESISTOR, 9.90 MEGOHMS	R1
05-114967	RESISTOR, 47 OHMS	R67

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STOCK PARTS

SIMPSON MODEL 464A DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
05-118419	RESISTOR, 68 OHMS	R63,64
05-114968	RESISTOR, 100 OHMS	R69,74,50,51,52
01-223781	SPRING, GROUND	
05-117179	RESISTOR, 220 OHMS	R70
05-116091	RESISTOR, 330 OHMS	R73
05-116366	RESISTOR, 750 OHMS	R76
05-113871	RESISTOR, 1K OHMS	R53,54,55,68
05-117714	RESISTOR, 5.1K OHMS	R47
05-113624	RESISTOR, 10K OHMS	R14,17
05-116134	RESISTOR, 15K OHMS	R48
05-117196	RESISTOR, 22K OHMS	R77
05-118431	RESISTOR, 27K OHMS	R78
05-113875	RESISTOR, 33K OHMS	R46,65,66
05-115962	RESISTOR, 68K OHMS	R75
05-115514	RESISTOR, 100K OHMS	R38
01-113949	RESISTOR, 100K OHMS	R26
05-116883	RESISTOR, 100K OHMS	R13
05-113627	RESISTOR, 120K OHMS	R18,12,39
05-114983	RESISTOR, 470K OHMS	R10,11,23
05-118421	RESISTOR, 470K OHMS	R36
05-114984	RESISTOR, 560K OHMS	R37
05-118422	RESISTOR, 4.7 MEGOHMS	R19
05-116632	RESISTOR, 10 MEGOHMS	R16
05-118423	RESISTOR, 15 MEGOHMS	R12
05-118424	RESISTOR, 22 MEGOHMS	R15
05-118425	RESISTOR, 68 OHMS	R56,62
05-118078	POT., 200 OHMS	R22
05-118079	POT., 1K OHMS	R29
05-118080	POT., 5K OHMS	R27
05-118081	POT., 10K OHMS	R40
05-118082	POT., 20K OHMS	R41
05-117739	CLIP, FUSE, P.C. MOUNTING	
05-115013	CONNECTOR, PIN	
05-118428	CABLE, RIBBON, 2 1/8	
05-116235	CAP., VAR., 5.5-60PF, 100V	C2,23
10-863211	BOARD, P.C. ASSY, READOUT	
05-117337	READOUT, LED, P/M 1	DS4
05-117338	READOUT, LED, 7 SEGMENT	DS1,2,3
05-168403	BRACKET, READOUT	

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SIMPSON MODEL 464A DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
05-118376	TRANSFORMER, POWER	T1
10-863216	BRACKET ASSEMBLY, POWER, CONNECTOR	
05-118077	SWITCH, PUSHBUTTON, 12	S1 THRU 12
01-113835	FUSE, 1/4A, 250V, 3AG-120V UNIT	F1
01-116104	FUSE, 1/8A, 250V, 3AG-240V UNIT	F1
05-118087	FUSE, 2.5A, 125V, 8AG	F2
05-118379	BUTTON, RED	
05-118378	BUTTON BLACK	
05-118086	BUTTON, GREY	
05-168401	SHIELD, A.C. AMP	
05-118453	CAP., 100UF, 16V	C33
05-118375	HANDLE, MOLDED	
05-118398	PLATE, HANDLE	
05-118373	CASE, BOTTOM, MOLDED	
05-328427	SPACER, HEX. 1.750 IN.	
01-117829	BUMPER, RUBBER FEET	
05-144572	SCREW, #4-40 X 1/2	
01-182270	SCREW,#6-32 X 5/16	
01-401866	LOCKWASHER, #6	
05-117452	LABEL, SERIAL NUMBER	
05-118429	LABEL, IDENTIFICATION AND SPEC.	

SHIPPING AND MANUAL

05-118430	MANUAL, INSTRUCTION M-464-A&D
05-118916	CORD, POWER
05-112473	BAG, PLASTIC, 15 x 17
05-118456	CONTAINER
05-118457	LABEL, IDENTIFICATION
05-116455	LABEL, 240 VAC
05-116805	LABEL, 1/8A
10-830115	TEST LEAD SET, DIST.STK. #00115

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312

SIMPSON MODEL 464D DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
	TESTER SECTION	
10-863218	PANEL ASSEMBLY	
05-118371	PANEL, PURCHASED	
05-118395	PANEL, OVERLAY, TOP	
05-118396	PANEL, OVERLAY, CENTER	
05-118397	PANEL, OVERLAY, BOTTOM	
05-117424	CONN, BANANA JACK, RED	
05-117423	CONNECTOR, BANANA JACK, BLACK	
05-116594	CONNECTOR, PIN JACK, WHITE	
05-116783	NUT, TINNERMAN FOR 5-116594	
10-650156	SHUNT, CURRENT, 10 AMP.	
10-863217	CASE ASSEMBLY, TOP	
10-863214	BOARD, P.C., ASSY., MAIN	
05-117723	I.C., LD110	IC6
05-117724	I.C., LD111	IC5
05-117150	I.C., NE555V	IC4
05-115927	I.C., DM7447N	IC7
05-115916	I.C., LM301AH	IC1
05-115928	I.C., SN72741P	IC3,8
05-116598	I.C., LM308N	IC2
05-115931	TRANS, 2N4123	Q1,2,10,11,12,13,18
05-115934	TRANSISTOR, GET2222	Q14,15
05-118404	TRANSISTOR, D40C1	Q19
05-115938	TRANSISTOR, 2N5306	Q4,5,17
05-112747	TRANSISTOR, 2N5458	Q3
05-117720	TRANSISTOR, 2N5815	Q16
05-114106	TRANSISTOR, 2N3638	Q6,7,8,9
05-117379	DIODE, 1N914 SELECTED	D1,2
05-118868	DIODE, DE-113	D3
05-112004	DIODE, 1N914	D8,9,10,19,20
05-113826	DIODE, 1N5059	D4,5,6,7
05-114005	DIODE, 10D1	D16,17,18
05-115945	DIODE, W005	RECT 1
05-112634	DIODE, 1N753A	ZD4,5
05-118917	DIODE, 1N757	ZD2
05-112726	DIODE, 1N4743A	ZD3
05-118918	DIODE, 1N936	ZD1

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STOCK PARTS

SIMPSON MODEL 464D DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
05-117138	CAP., 3.3PF, 1KV	C1
05-115992	CAP., 47PF, 160V	C11
05-113217	CAP., 100PF, 1KV	C31
05-112690	CAP., 330PF, 500V	C32
05-118405	CAP., 390PF, 250V	C3
05-118406	CAP., 470PF, 250V	C4
05-117201	CAP., .0022UF, 100V	C16
05-113215	CAP., .01UF, 50V	C9,10,17
05-117278	CAP., .01UF, 100V	C7
05-116188	CAP., .022UF, 100V	C20
05-117732	CAP., .033UF, 100V	C19,21
05-118449	CAP., .22UF, 630V	C5
05-113612	CAP., .1UF, 100V	C22
05-118407	CAP., .33UF, 100V	C12
05-115530	CAP., .47UF, 16V	C13
05-118085	CAP., 3.3UF, 25V	C28,29
05-117050	CAP., 100UF, 10V	C18
05-118426	CAP., 10UF, 25V	C26
05-116969	CAP., 10UF, 50V	C30
05-115534	CAP., 15 UF, 16V	C6,8,14,15
05-117737	CAP., 100UF, 25V	C27
05-118084	CAP., 2200UF, 16V	C25
05-118409	RESISTOR, 0.894 OHMS	R6
05-118410	RESISTOR, 9.0 OHMS	R7
05-116272	RESISTOR, 90.0 OHMS	R8
05-118411	RESISTOR, 448 OHMS	R24
05-116273	RESISTOR, 900 OHMS	R9
05-117695	RESISTOR, 4.0K OHMS	R30
05-118412	RESISTOR, 4.08K OHMS	R25
05-118413	RESISTOR, 10.0K OHMS	R20,21
05-118414	RESISTOR, 10.0K OHMS	R3
05-114962	RESISTOR, 10K OHMS	R33,34
05-116621	RESISTOR, 20.0K OHMS	R45
05-118415	RESISTOR, 36K OHMS	R31,32
05-118416	RESISTOR, 37.5K OHMS	R28
05-116921	RESISTOR, 75K OHMS	R42
05-118417	RESISTOR, 90.0K OHMS	R2
05-115506	RESISTOR, 100K OHMS	R43
05-117519	RESISTOR, 110K OHMS	R44
05-118418	RESISTOR, 9.90M OHMS	R1

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SIMPSON MODEL 464D DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
05-116772	RESISTOR, 402 OHMS	R35
05-113998	RESISTOR, 0.5 OHMS	R82
05-115117	RESISTOR, 10 OHMS	R49
05-118419	RESISTOR, 68 OHMS	R67
05-117178	RESISTOR, 100 OHMS	R63,64
05-114968	RESISTOR, 100 OHMS	R50,51,52,69,74
01-223781	SPRING, GROUND	
05-117179	RESISTOR, 220 OHMS	R70
05-114969	RESISTOR, 270 OHMS	R71
05-116091	RESISTOR, 330 OHMS	R35,73
05-118420	RESISTOR, 390 OHMS	R79
05-116366	RESISTOR, 750 OHMS	R76
05-113871	RESISTOR, 1K OHMS	R53,54,55,68,72
05-117714	RESISTOR, 5.1K OHMS	R47
05-113624	RESISTOR, 10K OHMS	R14,17
05-116134	RESISTOR, 15K OHMS	R48
05-115512	RESISTOR, 18K OHMS	R80
05-117196	RESISTOR, 22K OHMS	R77
05-118431	RESISTOR, 27K OHMS	R78
05-113875	RESISTOR, 33K OHMS	R46,65,66
05-115962	RESISTOR, 68K OHMS	R75
05-115514	RESISTOR, 100K OHMS	R38,83
01-113949	RESISTOR, 100K OHMS	R26
05-116883	RESISTOR, 100K OHMS	R13
05-113627	RESISTOR, 120K OHMS	R18,39
05-114983	RESISTOR, 470K OHMS	R10,11,23
05-118421	RESISTOR, 470K OHMS	R36
05-114984	RESISTOR, 560K OHMS	R37
05-118422	RESISTOR, 4.7 MEGOHMS	R19
05-116632	RESISTOR, 10 MEGOHMS	R16
05-118423	RESISTOR, 15 MEGOHMS	R12
05-118424	RESISTOR, 22 MEGOHMS	R15
05-118094	RES. NETWORK, 100 OHMS	R56 THRU 62
05-118078	POT, 200 OHMS	R22
05-113504	POT, 1K OHMS	R81
05-118079	POT, 1K OHMS	R29
05-118080	POT, 5K OHMS	R27
05-118081	POT, 10K OHMS	R40
05-118082	POT, 20K OHMS	R41

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SIMPSON ELECTRIC COMPANY
853 DUNDEE AVENUE
ELGIN, ILLINOIS 60120
PHONE 697-2260

STOCK PARTS

SIMPSON MODEL 464D DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION	
05-117739	CLIP, FUSE	
05-115013	CONNECTOR, PIN	
05-118428	CABLE RIBBON, 2-1/8	
05-116235	CAP., 5.5-60PF, 100V	C2,23
05-168403	BRACKET, READOUT	
10-863211	BOARD, P.C. ASSY., READOUT	
05-117337	READOUT, LED P/M 1	DS4
05-117338	READOUT, LED, 7 SEGMENT	DS1,2,3,
10-863216	BRACKET ASSEMBLY, POWER CONNECTOR	
05-118377	TRANSFORMER, DC-DC CONVERTER	T2
05-118077	SWITCH, BANK, PUSHBUTTON	S1 THRU 12
01-113835	FUSE, 1/4A, 250V - aa0V UNIT	F1
01-116104	FUSE, 1/8A 250V - 240V UNIT	F1
05-118087	FUSE, 2.5A, 125V, 8AG	F2
05-118379	BUTTON, RED	
05-118378	BUTTON, BLACK	
05-118086	BUTTON, GREY	
05-118399	HOLDER, BATTERY	
05-168401	SHIELD, AC AMP	
05-181478	NUT, HEX, #4-40X3/16	
05-182441	SCREW, #4-40 X 3/8	
05-402466	LOCKWASHER, #4	
05-118453	CAP., 100UF, 16V	C33
05-118375	HANDLE, MOLDED	
05-118398	PLATE, HANDLE	
05-118373	CASE, BOTTOM, MOLDED	
05-328427	SPACER, HEX, 1.750 IN.	
01-117829	BUMPER, RUBBER FEET	
05-144572	SCREW, #4-40 X 1/2	
01-182270	SCREW, #6-32 X 5/16	
01-401866	LOCKWASHER, #6	
05-117452	LABEL, SERIAL NO.	
05-118429	LABEL, IDENTIFICATION, SPECIFICATION	
05-118448	LABEL, IDENTIFICATION, D	
05-115599	TUBING	
05-115598	RUBBER BAND	

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SIMPSON ELECTRIC COMPANY
853 DUNDEE AVENUE
ELGIN, ILLINOIS 60120
PHONE 697-2260

STOCK PARTS

SIMPSON MODEL 464D DIGITAL MULTIMETER

PART NUMBER	DESCRIPTION
	SHIPPING AND MANUAL
05-118430	MANUAL, INSTRUCTION M-464-A & D
05-118916	CORD, POWER
05-112473	BAG, PLASTIC, 15 X 17
05-118456	CONTAINER
05-118457	LABEL, IDENTIFICATION
05-116455	LABEL, 240VAC
05-116805	LABEL, 1/8A
10-830115	TEST LEADS, DIST. STK. #00115

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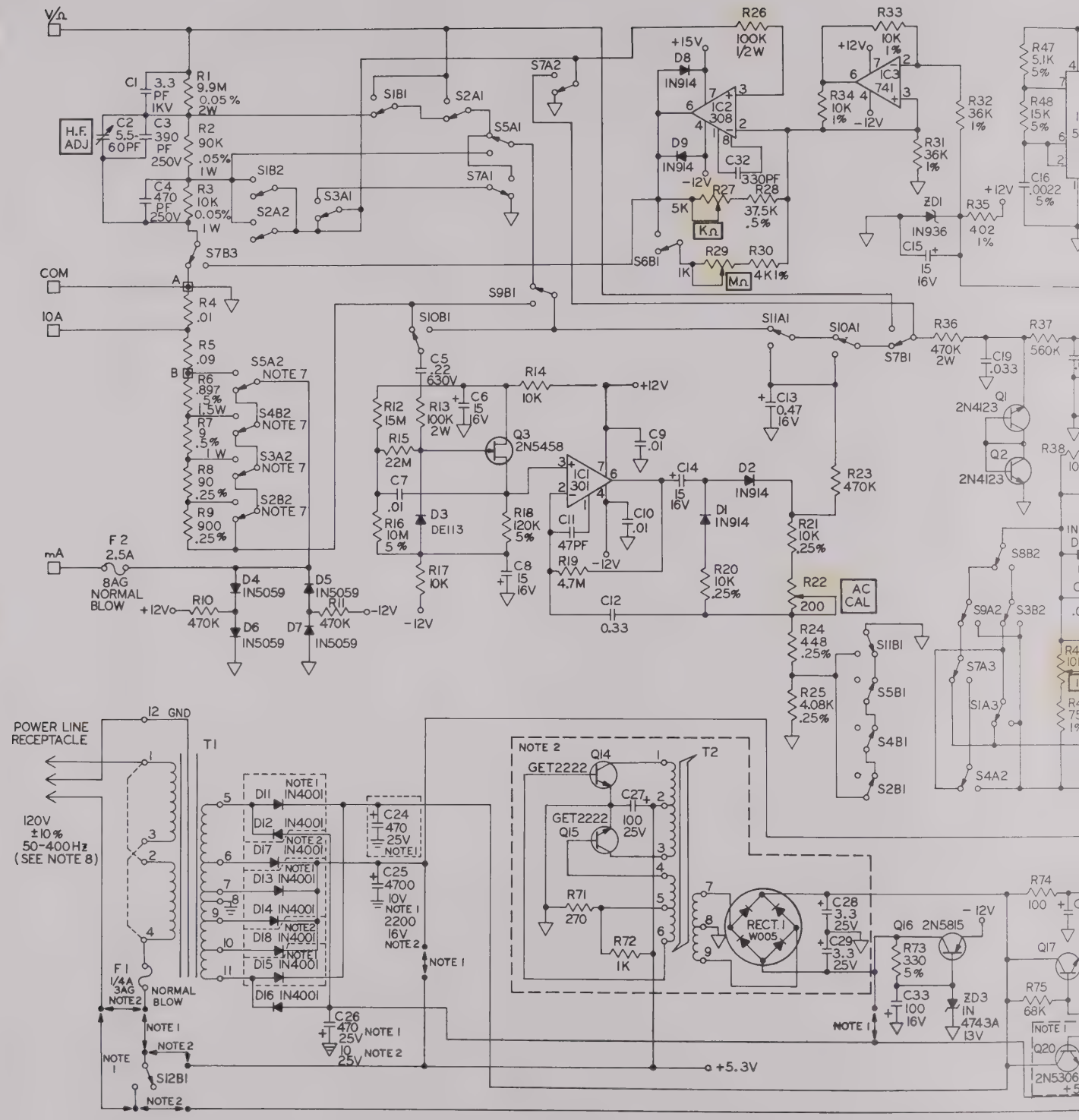
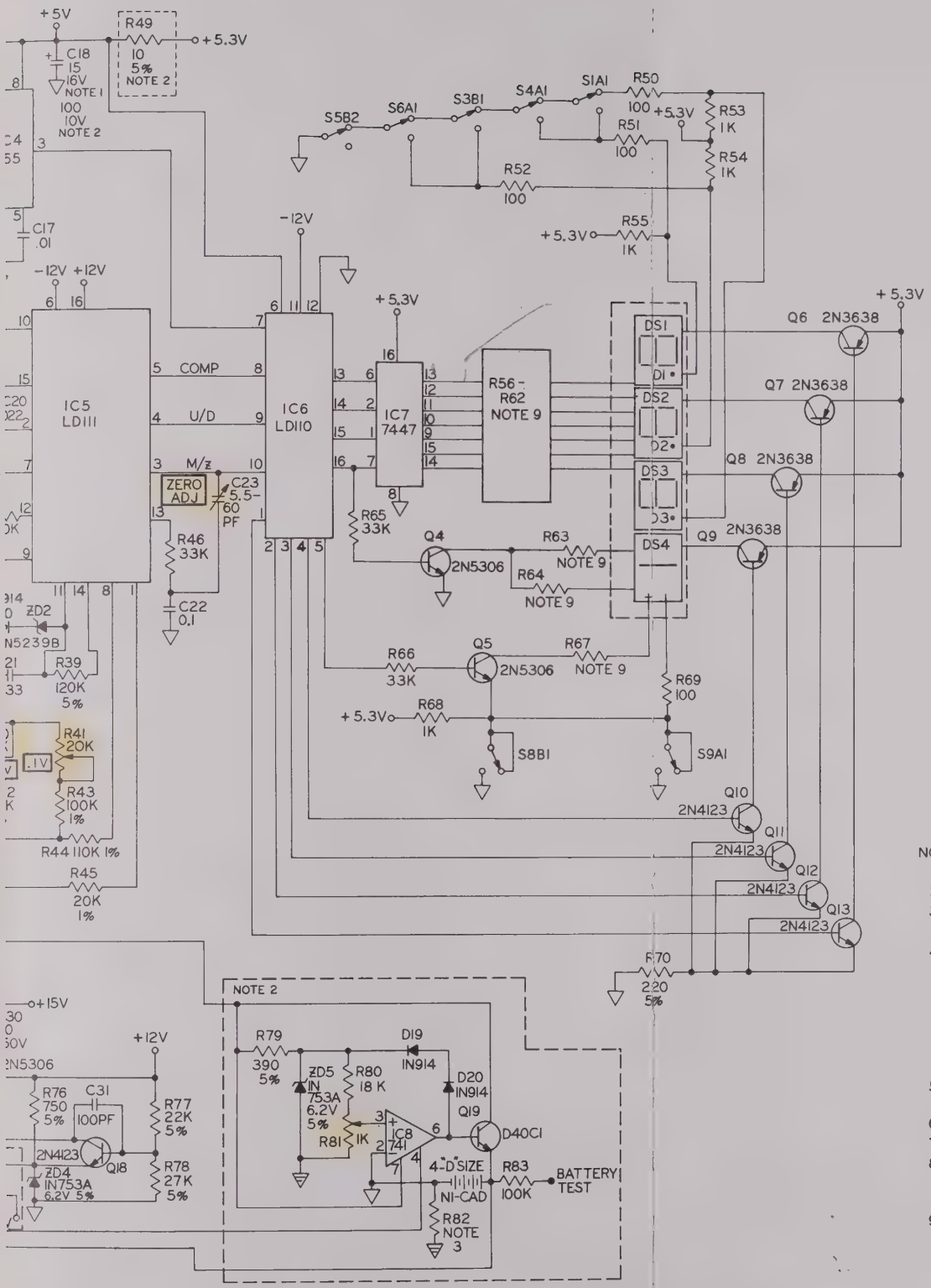

V/Ω
COM
10A
mA
H.F. ADJ
C1 3.3 PF 1KV
C2 5.5-60PF
C3 390 PF 250V
C4 470 PF 250V
R1 9.9M 0.05% 2W
R2 90K .05% 1W
R3 10K 0.05% 1W
R4 .01
R5 .09
R6 .897 5% 1.5W
R7 9 .5% 1W
R8 90 .25%
R9 900 .25%
S1B1
S2A1
S3A1
S5A1
S7A1
S7A2
S7B3
S2A2
S1B2
S5A2 NOTE 7
S4B2 NOTE 7
S3A2 NOTE 7
S2B2 NOTE 7
F 2 2.5A 8AG NORMAL BLOW
D4 IN5059
D5 IN5059
D6 IN5059
D7 IN5059
R10 470K
R11 470K
+12V
-12V
R26 100K 1/2W
+15V
D8 IN914
D9 IN914
IC2 308
C32 330PF
R27 5K
R28 37.5K .5%
R29 1K
R30 4K 1%
KΩ
MΩ
S6B1
R33 10K 1%
IC3 741
R34 10K 1%
R32 36K 1%
R31 36K 1%
ZD1 IN936
R35 402 1%
C15 15 16V
R47 5.1K 5%
R48 15K 5%
C16 .0022 5%
S9B1
S10B1
S11A1
S10A1
S7B1
R36 470K 2W
R37 560K
C19 .033
Q1 2N4123
Q2 2N4123
R38
C5 .22 630V
C6 15 16V
R14 10K
R12 15M
R13 100K 2W
R15 22M
C7 .01
R16 10M 5%
D3 DE113
Q3 2N5458
IC1 301
C9 .01
C10 .01
C11 47PF
R19 4.7M
C8 15 16V
R17 10K
C12 0.33
C14 15 16V
D2 IN914
D1 IN914
R20 10K .25%
C13 0.47 16V
R23 470K
R21 10K .25%
R22 200
AC CAL
R24 448 .25%
R25 4.08K .25%
S11B1
S5B1
S4B1
S2B1
S8B2
S9A2
S3B2
S7A3
S1A3
S4A2
POWER LINE RECEPTACLE
120V ±10% 50-400Hz (SEE NOTE 8)
T1
12 GND
F1 1/4A 3AG NORMAL BLOW NOTE 2
S12B1
DI1 IN4001 NOTE 1
DI2 IN4001
DI7 IN4001 NOTE 2
DI3 IN4001 NOTE 1
DI4 IN4001
DI8 IN4001 NOTE 2
DI5 IN4001 NOTE 1
DI6 IN4001
C24 470 25V NOTE 1
C25 4700 10V NOTE 1
2200 16V NOTE 2
C26 470 25V NOTE 1
10 25V NOTE 2
NOTE 2
Q14 GET2222
Q15 GET2222
T2
C27 100 25V
R71 270
R72 1K
RECT.1 W005
C28 3.3 25V
C29 3.3 25V
+5.3V
Q16 2N5815
R73 330 5%
C33 100 16V
ZD3 IN 4743A 13V
R74 100
Q17
R75 68K
Q20
2N5306



NOTES

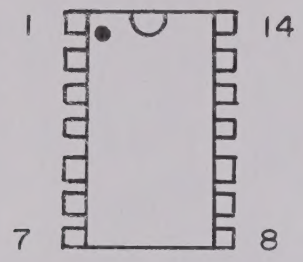
1. LINE VERSION ONLY. MODEL 464A
2. BATTERY VERSION ONLY. MODEL 464D
3. LINE VERSION- JUMPER
   BATTERY VERSION-.5Ω,1%
4. ALL SWITCHES SHOWN IN
   OUT POSITION.

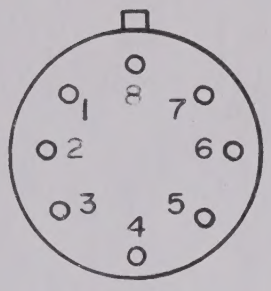
S1-.2	S7-KΩ
S2-2	S8-DCV
S3-20	S9-DC I
S4-200	S10-ACV
S5-2000	S11-AC I
S6-20MΩ	S12-POWER

5. ALL RESISTORS 1/4W, 10% UNLESS OTHERWISE STATED.
6. CAPACITORS IN μfd.
7. MAKE BEFORE BREAK CONTACTS.
8. FOR 120V JUMPER PIN 1 TO PIN 2 AND PIN 3 TO PIN 4.
   FOR 240V JUMPER PIN 2 TO PIN 3.
9. LINE VERSION: R56-R64 = 68Ω,5%
   R67 = 47Ω
   BATTERY VERSION: R56-R64 = 100Ω,5%
   R67 = 68Ω,5%

FIGURE 6-1 SCHEMATIC DIAGRAM, MODELS 464A AND 464D.

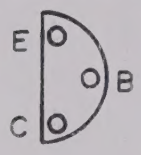
Integrated Circuits (Top View)



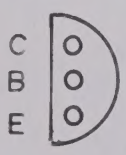


Transistors (Bottom View)

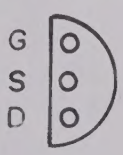
2N5306
2N5815
GET2222



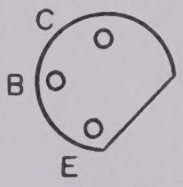
2N4123



2N5458



2N3638



[40CI (Side View)

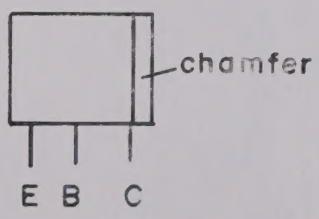


Fig. 6-2. Semiconductor Lead Identification

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